SECRET

25X1A

[redacted]1992-62
Copy 2 of 4

21 August 1962

MEMORANDUM FOR: Director, NPIC

25X1A THROUGH : Acting Director, OSA

ATTENTION : [redacted]

SUBJECT : Monthly Status Report
Contract No. HB-425, T.O. No. 4
Image Enhancement

Forwarded herewith for your information and file are two (2) copies each of the subject report covering the period 21 June - 20 July 1962.

25X1A [redacted]

Chief, Contracts Division, OSA

Attachment: as stated

25X1A

CD/OSA-DD/R:[redacted]
Cy 1 - NPIC w/att.
2 - CD OSA HB-425 T.O. 4 w/att. T&P
3 - AD/OSA
4 - RB/OSA

25X1A Handle via [redacted] Channel System

SECRET

Encl #1
COR-1752
COPY 1 OF 2

JIM

9043-62-7C

July 31, 1962

Dear Jim:

Attached are three (3) copies of the Monthly Status Letter on Task Order #4, Contract BB-425. You will note that reference is made to a verbal report which is to be made subsequent to completion of Phase 1 of this contract. We will be prepared to present this report on or about 15 August. I have discussed this matter informally with M. Kruger who has informed me that he will probably plan to receive the verbal report at our facility during the week ending 19 August 1962. Would you kindly confirm this information.

Thank you for your consideration in this matter.

Very truly yours,

[redacted]

Contracts Manager

25X1A

HAM:mk

Enclosures 3

9043 MONTHLY STATUS LETTER

21 June 1962 - 20 July 1962

ENGINEERING, FABRICATION, AND DEVELOPMENT PROGRESS:

Assembly of the modified viewing equipment has begun, and all major components are at hand. This unit will be assembled and tested without external metal finishing (in terms of anodizing and/or painting), in order that Phase II fabrication can be finished compatibly. The previous report detailed the optical modifications, and gave only a basic design idea for the improved photographic capability. The 70mm format will be accomplished through a Linhof Cine Rollex Back, especially adapted for the present purposes. Exact location of the focal plane with respect to the optical image in the viewing binoculars will be achieved by the insertion and calibrated placement of a microscope (100x) through the format back. A ground-glass screen will permit viewing of the unmagnified image field, and can be easily pushed back out of the way and stored when it is desired to view the aerial image directly.

Frequency space on the Image Enhancement Viewer has been "calibrated" to account for the effect of the glass in the fluid gate. The nominal focal length of the collimator, 622mm, has been shortened to an effective 582mm. This has resulted in an increase of about 6% in the spatial filter sizes listed in the operating and maintenance manual. Subsequent experimental work has accomodated this fact. Phase I modifications will not change this value, since the collimators will not be relocated (as reported previously). It is expected that Phase II modifications will return to the original value.

Difficulties in the procurement of parts, and the natural time delay between order and receipt will delay total assembly, calibration, and test of this modification, as well as the incorporation of the shutter mechanism. All parts and sub-assemblies have quoted delivery dates prior to 31 July, and it is

anticipated that these dates will be met. However, it is also estimated that the unit will not be complete and tested before 9 August 1962.

The design of the experimental rotating spatial filter mechanism has been completed, parts purchased and fabricated, and the basic assembly (without the filter) scheduled for 23 July. The rotating device consists of a Servo-Tek 1/20 HP motor controlled through a diode bridge circuit and rheostat, coupled through a timing belt and appropriate sprockets to the filter holder which is mounted in a large-diameter inner bearing race. The outer race is held fixed, with vertical and horizontal adjustments made on the frame to which the outer race is fixed. The unit will be capable of speeds up to 2000 RPM, and could be increased to 5000 RPM with a larger driver sprocket. The motor will be mounted on a plate which is isolated from the optical bench through LORD Multiplane vibration isolaters. Similar isolation of the bearing and filter will be impossible because of the requisite optical alignment. Upon assembly of this unit, test will be carried out to assess the effect of vibration on the aerial image, without filter. Delivery of the filters is scheduled for the latter part of the week of the 22nd, and on the assumption that this will be met, evaluation of the rotating filters should be completed by 31 August, as originally scheduled.

THEORETICAL STUDIES:

The mathematical formulation of a photographic edge was developed, but remains unverified at this writing. Difficulties were encountered in interpreting edge behavior in terms of the pulse studies previously reported. It was felt that an attempt at formulating the edge response should be made, in view of its more specific application and immediate usefulness for evaluating the filters. Simultaneous study of pulse and edge is presently being carried out and experiments planned to further test the results.

It is expected that a preliminary evaluation of the occluding filter will be made and noted in the report due at the end of Phase I. Improvement of the image edge through spatial filtering, exposure addition, and the multiplication of photographic images has been formulated mathematically. Preliminary experimentation verify these results qualitatively; the wait for suitable precision equipment has hampered the extensive experimental work necessary to pin down these findings quantitatively. It is hoped that a useful, quantitative report on these latter theorizings and experiments will be included in the Phase I final report, but present indications are that it will be delayed.

EXPERIMENTAL:

Photographic edges of a precise gradient and transmission end-points have been produced experimentally. These edges have been placed in the linear optical system of the Image Enhancement Viewer and filtered and unfiltered images recorded photographically. The results of these experiments require more time to evaluate, but do indicate the need for further experiments in which the parameters are varied more widely. The techniques have been set up, and the additional experimentation will not require as much time to carry out.

Techniques for "enhancement" by exposure addition have been developed, and several experiments carried out. The basic idea behind this was noted in the last monthly report, indicating three ways of operating on an image. It is known that filtering the spectrum of an edge with a sharp cutoff, occluding filter locates the edge quite precisely, but tends to remove or lower the density difference across it. Except for mensuration possibilities and for purposes of improved delineation, it is of no use in improving or enhancing image perception, per se, in the general manner desired.

Adding exposures produced by an unfiltered image and an image from which the lower spatial frequencies have been removed is a technique of building up

the regions of the image which are considered important. Thus, across an edge, it would be useful to retain or improve the density difference and increase the gradient. It is known that edges which are not "sharp" contain only the lower spatial frequency components when subjected to Fourier analysis. The sharper the pulse, (or edge) the higher the spatial frequency content. Thus, there is a definite tie-in of high spatial frequencies and sharpness of edges. In theory, therefore, adding high spatial frequencies to an edge would tend to reinforce those components which contribute to the desired edge characteristic. It is obvious that these higher spatial frequencies must bear some relationship to the original edge in order for them to add constructively.

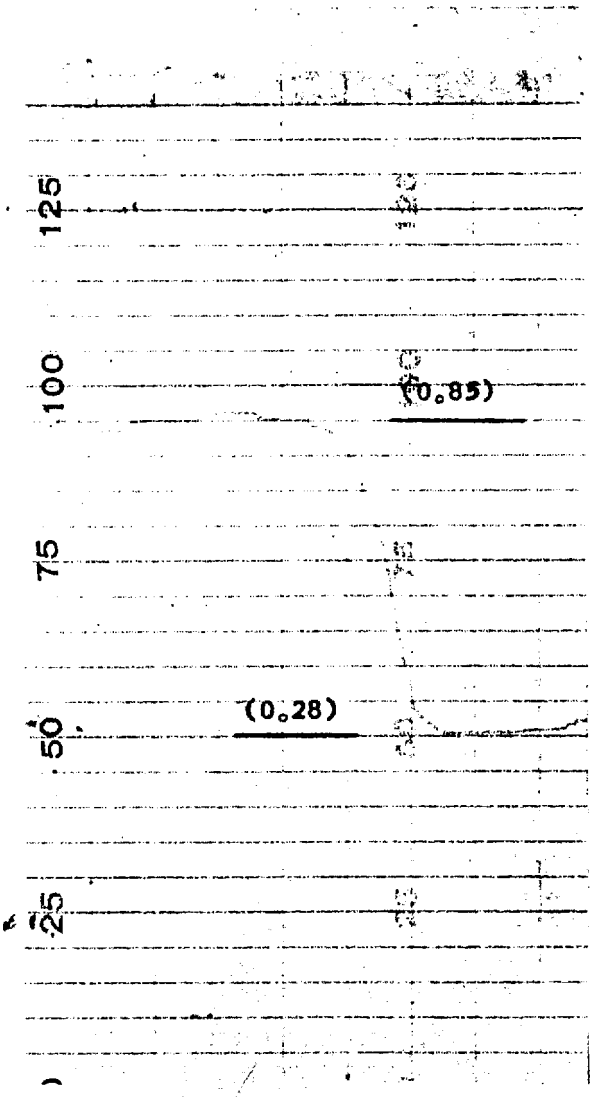
Of the two ways of experimentally realizing this, one was tried; exposure addition. The accompanying Figure shows a typical result. The Figure captions explain the details with sufficient clarity to eliminate their explanation here. The main conclusion to be drawn from the comparison is that while the gradient has not been improved (in fact, degraded quite a bit), the density difference has been increased in the region of the edge. The density difference between the flat areas is exactly the same in both cases. Then the contrast has been improved near the edge, and tonal quality has been preserved. The method of exposure addition tends to produce contrast improvement; the mathematical description of image multiplication indicates that a gradient improvement is more favorable in that case. These experiments require additional refinements before more quantitative results appear, and the method of image multiplication remains to be considered experimentally.

It is not likely that definite, final results will be established by the time of Phase I final report, in view of the extensive experimentation and necessary data analysis still pending.

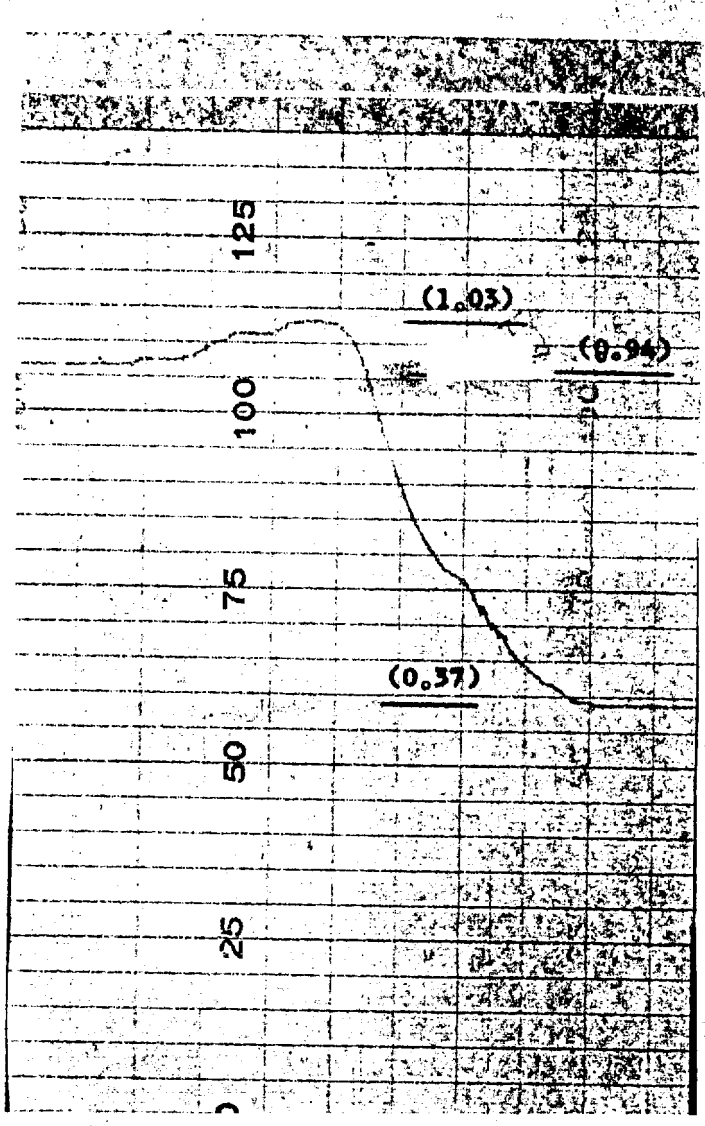
GENERAL SUMMARY:

Progress has been made in all areas of research and engineering. Delivery schedules and fabrication lead-time has forced delay of the completion of the viewer modification until at least the 9th of August. Despite this delay, the evaluation of the rotating filter principle should be accomplished by 31 July. Theoretical developments have been extended to cover the case of edges, but await experimental verification. Experiments on edges and enhancement techniques have been carried out, and while the results have been enlightening, they have not been of sufficient breadth to report definitively.

It is expected that the verbal report on Phase I will be ready for submission by 12 August, and it is suggested that this report be given the week of 12 August or the week of 19 August, whichever is more convenient to the contracting agency. The written report will be delayed by an additional two weeks, to 31 August. However, the verbal report should be sufficient to establish a basis for prosecution of the Phase II developments.



Unfiltered image - exposed for 8 seconds.



Exposure addition in which the original image was exposed for 8 seconds and the filtered image for 90 seconds. The filter occluded all frequencies below 1.5 cycles/mm.

Microdensitometer traces of the photographic images of an edge, showing the effect of adding a spatially filtered image to the original image, in exposure. Chart scales have been converted to density where applicable, and the density values placed in parentheses.